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Does Individual Innovativeness Influence TPACK Development?: The Case of Pre-service EFL Teachers in Türkiye

Taibe Kulaksız
Heidelberg University of Education, Germany

Abstract: This study aims to investigate how pre-service EFL teachers' individual innovativeness levels affect their TPACK development during an educational technology course. Employing a quasi-experimental research design, the participants were 59 pre-service EFL teachers. The course followed the Diffusion of Innovation Theory steps. Analyzing the data, TPACK and individual innovativeness scales were implemented as pre- and post-tests. The results showed a significant increase in participants' TPACK, while their individual innovativeness did not exhibit a significant change during the course. Although there was a notable difference in pre-service teachers' initial TPACK levels based on their innovativeness, this difference was no longer significant in the end. Education for TPACK development is critical in bridging the initial knowledge gap arising from differing innovativeness levels.

Introduction

The support of technology in language education enhances learners' writing quality, literacy development, and word retention (Lee et al., 2022; Lin & Lin, 2019; Xu et al., 2019). This evidence suggests that an essential teaching competency in language education is the ability to integrate technologies into the teaching process. Technological Pedagogical Content Knowledge (TPACK) proposed by Koehler and Mishra (2009) provides a framework for teachers' subject-specific technology skills in teaching settings. However, TPACK studies in the field of EFL teacher education studies are limited and lack experimental/quasi-experimental research designs to observe the effectiveness of the educational technology courses (Çınar, 2022; Tseng et al., 2020). Therefore, it is crucial to prioritize the development of pre-service English as a foreign language (EFL) teachers' TPACK in teacher education programs.

Numerous variables and actors take part in the context of the construction of teachers' TPACK (Brianza et al., 2022; Harris & Huang, 2023; Karakaya Cirit & Canpolat, 2019; Kulaksız & Karaca, 2023). Some of these factors are related to social, resource, and content, while others are associated with actors' behaviors in the context such as teachers' beliefs and attitudes (Brianza et al., 2022). Innovativeness was identified as a significant factor affecting teachers' technological skills and intentions by several researchers (Çoklar & Özbek, 2017; Mazman Akar, 2019; Uslu, 2018). Teachers with high innovativeness levels tend to embrace technologies more readily (Mazman Akar, 2019) and preservice teachers often exhibit higher Information and Communication Technologies (ICT) competencies (Mumcu, 2022). However, resistance to change is an attribution of human innovativeness that distinguishes different categories of innovation adopters (Rogers, 2003).

It is highly likely that innovative pre-service teachers are expected to have technological affinities. In this context, a question that arises is how long the gap between the

technology integration skills of pre-service teachers with high innovativeness and those with low innovativeness will persist. However, it is not easy to address the possibility of resolving these initial personal differences since this trait is change-resistant. Hence, instructional technologies courses provide an opportunity in terms of allowing pre-service teachers to meet and adapt to technological devices and applications in education and to improve their TPACK. In this way, this allows for observation of whether pre-service teachers can acquire TPACK knowledge and skills and whether they are persuaded to accept new technologies experimentally. As it is seen, it is possible to say that disregarding this well-known finding is common in available training programs. Therefore, the motivation behind this study is to explore whether the initial TPACK differences arising from the innovativeness can be eliminated when pre-service teachers undergo the same education program.

Theoretical Background

Technological Pedagogical Content Knowledge (TPACK) in Pre-service Teacher Education

Conceptualizing teachers' technology integration knowledge and skills, TPACK was proposed by Koehler and Mishra (2009). It is structured around three main knowledge areas: technology, pedagogy, and content. The intersection of these areas gave rise to a unique form of knowledge called "Technological Pedagogical Content Knowledge", which characterized the teachers' specific skills in using ubiquitous technologies meaningfully in subject-domain teaching. TPACK in practice manifests itself in several dimensions including understanding students, representing content, curriculum design, teaching, and assessment (Ay et al., 2015). However, researchers continue to explore key questions such as the definition of TPACK, its components, the boundaries between these components, and the elements of the nature of TPACK (Saubern et al., 2019). In 2019, TPACK was upgraded about its neglected "context" element, which was then referred to as "contextual knowledge" (Mishra, 2019). Recently, Bueno et al. (2023) described TPACK as "homogeneous and transformative knowledge" and invited researchers and teacher educators to consider TPACK as cohesive body knowledge rather than separated sub-domain knowledge for specific-subject teaching.

In enhancing pre-service teachers' TPACK, educational technology courses play a vital role (Çınar, 2022). Presenting appropriate guidelines, scaffolding, and demonstrations during the educational technology classes in the teacher education programs supports pre-service teachers' competencies in integrating technology into lessons (Wang et al., 2018). Various studies have applied different approaches to improve pre-service teachers' technology integration knowledge and skills (Aldemir Engin et al., (2023); Kulaksız & Toran, 2022; Lachner et al., 2021). Successful interventions for language teachers' TPACK development include collaborative lesson designing, understanding TPACK, and modeling (Tseng et al., 2020). However, pre-service teachers' TPACK development is not standardized; it is rather an individualized process (Bueno et al., 2023).

The "one size does not fit all" approach in pre-service teacher digital competency education has been re-emphasized (Tondeur et al., 2021). Because TPACK is known to be influenced by many factors such as beliefs and attitudes, innovativeness, technology experience, gender, technology ownership, seniority in teaching, and collegial interaction (Brianza et al., 2022; Çınar; 2022; Kulaksız & Karaca, 2023; Uslu, 2018; Zhang & Chen, 2022). The factors influencing TPACK were revealed through studies using surveys or qualitative methods. Nevertheless, how existing factors affect pre-service teachers' TPACK during educational progress remains mostly unanswered because of the lack of intervention studies involving these variables. Furthermore, how these factors as dependent or covariate variables act and change during the TPACK development is quite limited.

Individual Innovativeness in Technology Integration in Education

The diffusion of innovations was defined by Rogers (2003) as having four fundamental elements: "the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system" (p. 53). According to him, innovation such as a new idea, object, and implementation adaptations, is associated with its features about the relative advantage of the innovation, its compatibility degree, its complexity for comprehension, trialability of the innovation, and observability of the innovation's results. The individual's innovation-decision progresses in line with the phases of getting knowledge, persuasion, decision, and confirmation, respectively, over time. The knowledge phase starts with awareness of the "new" existence and its functions. Following the persuasion of the innovation, the individual develops positive or negative attitudes regarding the knowledge they gained. The decision phase unveils where the person determines their adoption or rejection. The implementation phase indicates innovation usage, and the confirmation means a person re-apply an accepted innovation.

On the other hand, innovativeness, as a personality construct, defines the individual's "willingness to change" (Hurt et al., 1977). The psychometric features of individual innovativeness demonstrate resistance to change, opinion leadership, openness to experience, and risk-taking (Kılıçer & Odabaşı, 2010). Furthermore, there are different sorts of identification for innovation adopter types, which are normally distributed in the population (Hurt et al., 1977). Innovation adopters were categorized as laggards, late majority, early majority, early adopters, and innovators in the social system (Hurt et al., 1977; Rogers, 2003). Technology adoption and use in many aspects such as performance and effort expectancy, social influence, and personal innovativeness, are closely related (Blut et al., 2022). The motivation to transfer innovation in the teaching-learning process is associated with teachers' personal characteristics, social practices, and the perceived value of technology (Stumbrienė et al., 2023). Therefore, the innovativeness differences can lead to a multi-dimensional gap among pre/in-service teachers.

Mazman Akar (2019) examined teachers' behavioral intentions via the Technology Acceptance Model, including individual innovativeness. The results showed that teachers' innovativeness is closely related to perceived usefulness, perceived ease of use, subjective norms, and behavioral intentions. Furthermore, the highly innovative group of teachers demonstrated differences in terms of ICT acceptance and use. Mumcu (2022) also reported a positive and meaningful relationship between pre-service teachers' ICT competencies and individual innovativeness. Bakır's study results (2022) indicated a significant association between innovative teacher characteristics and technology integration levels. Evidently, innovativeness is an important variable in enhancing instructional design ICT competencies (Mumcu, 2022) and online education competencies (Nayci, 2021).

Moreover, individual innovativeness is one of the most influential factors on TPACK (Uslu, 2018). Teachers with high innovativeness levels have higher TPACK skills (Tüfekçi & Candan, 2023). Çoklar and Özbek's (2017) study results revealed that innovativeness is a significant determinant of teachers' TPACK self-efficacy, and TPACK scores meaningfully differ based on their adoption level of innovations. Therefore, it is suggested that diverse roles, strategies, and approaches should be applied to meet teachers' need to integrate technology into education due to individual differences in innovativeness (Martins, 2018; Stumbrienė et al., 2023). Furthermore, support mechanisms ought to be tailored as teachers have different attitudes and motivations for digital education. Thus, it was considered worthwhile in this study to examine the role of field-specific education in the development of pre-service teachers' skills in using technology in education according to their level of innovativeness.

Even though affective variables such as demographics, individual, and organizational factors, peer support, and information literacy influence teachers' innovative behaviors (Tura & Akbaşlı, 2021; Wu et al., 2022), innovativeness remains a kind of change-resistant characteristic. Additionally, training programs for knowledge and skill development generally do not aim to change individuals' personality traits. Hence, the motive of this study is to explore the development of the skills of individuals with different innovativeness levels participating in identical training. In this context, pre-service EFL teachers with different levels of innovativeness participated in the same course to preserve the naturality of the teacher education program, and their TPACK advancement was examined. The results of this study are considered important in terms of demonstrating pre-service teachers' acceptance process of innovations regarding the use of technology in education, and their TPACK developments by the innovativeness levels. The findings provide evidence on whether individual innovativeness, as a variable that has been differentiated statistically by previous studies, requires different interventions in an authentic learning environment.

Research aim

This study aims to investigate how pre-service EFL teachers' individual innovativeness levels affect their TPACK development during an educational technology course. In this regard, the following research questions are sought:

1. Do pre-test scores of pre-service teachers' TPACK differ based on their individual innovativeness levels?
2. Is there a significant difference between pre-service teachers' individual innovativeness pre-post test scores?
3. Is there a significant difference between pre-service teachers' TPACK pre-post test scores?
4. How do pre-service teachers' TPACK pre-post test scores change by their innovativeness levels?
5. Do the post-test scores of pre-service teachers' TPACK vary depending on their individual innovativeness levels?
6. What is the preference of pre-service teachers when they have the choice of developing educational material (digital, non-digital educational material, both) at the end of the course based on their individual innovativeness levels?

Method

Research Design

A quasi-experimental design model was used in this study. The quasi-experimental design is preferred due to the non-randomized assignment of the participants to ensure the internal validity of the study (Fraenkel et al., 2012). The research design of the study is presented in Figure 1.

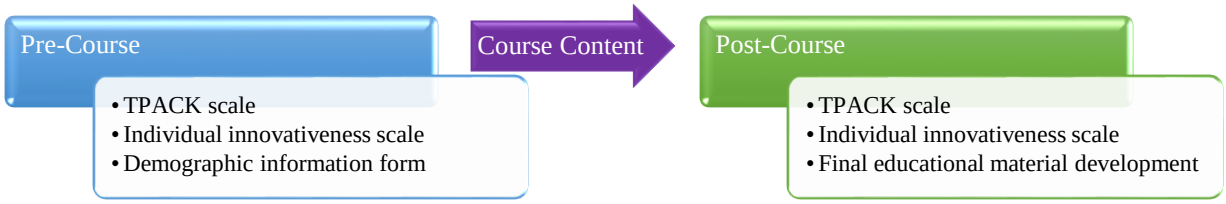

Figure 1: Research design

Participants and Context of The Study

The study started with 66 pre-service EFL teachers. The analyses were conducted with 18 male and 41 female pre-service EFL teachers (N=59) due to missing data. Their ages were between 19-42. The majority of them had their own laptop (N=50). Sixteen participants had prior knowledge of lesson planning and educational material development (limited to flashcards and worksheets, and presentations). All of them had introductory computer lessons which included basic principles of information technologies.

The research was carried out in an English Language Teaching Program at a university in Türkiye. The four-year teacher education program structure consists of courses related to subject knowledge such as English Literature, Linguistics, English-Turkish Translation, and pedagogical knowledge such as Introduction to Educational Sciences, and Approaches to ELT. This study was conducted in the Instructional Technologies and Material Development Course in the second year of the teacher education program in the spring semester of 2019.

Implementation Process

In this study, pre-service EFL teachers' technology integrations were contextualized in the Instructional Technology and Material Development course. The first three stages of Diffusion of Innovation (Rogers, 2003) were followed during the semester: Knowledge>Persuasion>Decision. Their familiarity and knowledge of technology use in education established the starting point of the research. Their demographics were obtained, and the new technological tools were introduced in the knowledge phase. The course was designed to provide opportunities to explore the learnability, benefits, and usability of digital tools for the persuasion step. Finally, at the end of the semester, pre-service teachers were given free will to develop their final projects based on digital or non-digital formats, which was the decisive step. The decision phase was focused on the optional innovation decisions that pre-service EFL teachers accept or reject the proposed instructional technologies.

The Instructional Technologies and Material Development course lasted a 14-week including theoretical and implementation parts as shown in Table 1. The course started with the pre-course data collection in the first week, where familiarity and experience with the educational materials were discussed class-wide. It was evident that all students had opinions about non-digital educational materials (such as textbooks, handmade posters, charts, and puppets) as well as basic computer use. However, their digital educational material preparation knowledge was limited to designing flashcards and worksheets in Word, and presentations in PowerPoint. Then, the fundamentals of instructional technology were presented. Students were asked about the most fruitful and needed technologies for English language teaching, and top-rated tools in the classroom were included in the course content. Web 2.0 tools, a collection of web-based applications enabling students and teachers to communicate and cooperate with each other, generate content, and share their ideas (e.g. Kahoot!, Padlet, MindMeister, Poll Everywhere), were designated by the instructor based on their requirements. Therefore, it was ensured that all pre-service teachers were novices in the use of the selected Web 2.0 tools. The participants were divided into two-person groups for peer studies throughout the whole semester. Between the second and seventh weeks, the ADDIE Model and each phase of the model were presented in detail. Parallelly, individual instructions for Web 2.0 tools were provided through task-based learning for each tool. This approach facilitated modeling, and scaffolding mechanisms to boost pre-service teachers' TPACK development. Every week during peer study sessions, pre-service teachers wrote reports for each phase of the ADDIE regarding learning outcome(s) selected from the English

Language curriculum. ADDIE report templates for each step were provided to participants to scaffold their instructional design process. Following the next three weeks, the fundamentals of distance education were covered, along with an examination of the well-known distance education platforms (e.g., edX, Khan Academy). Students were involved in the design and development of distance course procedures using Canvas. They included different types of course content such as text, video, presentation, quiz, and homework, regarding their task-based sheets. They had the flexibility to embed either their digital educational materials developed in previous weeks or find new educational materials on the internet. Final projects were developed by groups for two weeks where they could use any kind of tools and learning outcomes. The final projects consisted of ADDIE reports and at least one educational material. The choice and amount of educational material, whether digital, non-digital, or both, were entirely dependent on the groups. In the last week, the projects were demonstrated, and feedback was given in the class by peers and the instructor.

Week	Theoretical Part	Implementation Part
1	Fundamentals of instructional technologies	
2-7	ADDIE Model Analysis Design Development Implementation Evaluation	Cloud Technologies Presentations 2D visual materials Digital assessment and evaluation Animations Interactive Videos
8	Mid-Evaluation and Feedback	
9-11	Fundamentals of distance education Design and development of distance course	Course development Course descriptions Adding different types of course content Developing exam/homework Feedback Testing
12-13	Final Project Development	
14	Project Presentations and Feedback	

Table 1: Course content

Data Collection and Analysis

In this study, both qualitative and quantitative data collection tools were utilized, and detailed information is provided below.

TPACK-Practical Scale: The scale, consisting of 22-item with a 5-point Likert response type, was developed by Yeh et al. (2014) and adapted into Turkish by Ay et al. (2015) to measure pre-service teachers' TPACK skills. Cronbach's Alpha reliability coefficient of the scale was reported as .89 by Ay et al. (2015). In this study, Cronbach's Alpha was calculated as .987 for the pre-test and as .947 for the post-test. The total scores on the scale range from 22 to 110, with higher scores indicating higher TPACK.

Individual Innovativeness Scale: The scale, developed by Hurt et al. (1977) and adapted to Turkish by Kılıçer and Odabaşı (2010), consists of 20 items (including 8 negative items) with a 5-point Likert response type. The internal consistency was α=.82. Cronbach's Alpha for the pre-test was calculated as .840 and for the post-test .894. The total scores are calculated as (total positive item score - total negative item score + 42), varying between 14-96. Participants are classified as Innovators if they score above 80 points, Early Adopters if they score between 69-80 points, Early Majority if they score between 57-68 points, Late Majority if they score between 46-56 points, and Laggards if they score 46 points or lower.

Demographic Information Form: This form consists of seven questions about participants' age, gender, whether taking a technology lesson at the university, their experience in developing a lesson plan, and educational material ([if applicable]- what type), and whether they own a computer.

Final Educational Material Development Preferences: At the end of the course, pre-service teachers develop a final project to reflect their acquired TPACK skills. The project includes ADDIE reports, at least one material, which can be in digital, non-digital, or both formats. They had the option to choose from all types of educational materials for their project.

At the beginning of the course, the TPACK scale, individual innovativeness scale, and demographic information form were administered through Google Forms. At the end of the course, the TPACK scale and individual innovativeness scale form were administered again. The final projects were collected. The data gathered from the scales were initially analyzed if they met the assumptions of the parametric statistics. Shapiro-Wilk test, histograms for normality, and Levene test for homogeneity were performed. Afterward, descriptive statistics, Kruskal-Wallis, Mann-Whitney U, ANOVA, independent t-test, and dependent t-test were used regarding research questions. The final projects were categorized as digital if all educational material(s) were in digital format, non-digital if any educational material(s) were not digital, and both if the project consisted of at least one digital and one non-digital educational material. Finally, the author declares that she followed the "Declaration of Helsinki" for this study. All procedures involving human participants were in accordance with the ethical standards of the institutional and/or national research committee. Informed consent was obtained from all individual participants included in the study.

Findings

The findings of the study are presented below according to the research questions. As shown in Table 2, 5 participants belonged to the late majority, 24 were the early majority, 22 were the early adopters, and 8 were innovators out of the total of 59 participants. No laggards were detected.

Group	N	Mean of Rank	df	x^2	p	Difference
Late Majority (2)	5	14.10	3	8.903	.031	2-4
Early Majority (3)	24	26.71				2-5
Early Adopters (4)	22	33.50				
Innovators (5)	8	40.19				

Table 2: Pre-test scores of pre-service teachers' TPACK based on their individual innovativeness levels

Initially, the necessary assumptions were checked to answer the first research question. The Shapiro–Wilk Normality Test was used for normality, but it was violated ($p<.05$). The assumption that variances of the groups were not homogeneous was determined by the Levene Test results ($p<.05$). Accordingly, Kruskal Wallis was conducted whether pre-test scores of pre-service EFL teachers' TPACK differ by their individual innovativeness levels (Table 2). The results indicate that there was a significant difference between groups ($X^2=8.903$, $p<.05$). The difference was compared by the Mann-Whitney U test. As a result, there were significant differences between the Late Majority and Early Adopters ($U= 19.500$, $p<.05$.), and Late Majority and Innovators ($U= 5.0$, $p<.05$.) to the detriment of the Late Majority pre-service teachers.

	Mean	N	Std. Deviation	df	t	p
Pre-test	69.5085	59	9.97129	58	-1.572	.121
Post-test	70.9831	59	11.64932			

Table 3: Pre-service teachers' individual innovativeness pre-post test scores

For the second research question, the Shapiro–Wilk Normality Test was satisfied (p>.05). The dependent t-test was calculated whether there was a significant difference between pre-service teachers' individual innovativeness pre-post test scores (Table 3). As a result of the dependent t-test, there were no significant differences between their pre-test scores (M = 69.5085, SD = 9.97129) and post-test scores (M = 70.9831, SD =11.64932) of the pre-service teachers' individual innovativeness ($t_{(58)}$ = -1.572, p > .05).

	Mean	N	Std. Deviation	df	t	p
Pre-test	55.1186	59	25.01729	58	-10.526	.000
Post-test	90.0847	59	12.08488			

Table 4: Pre-service teachers' TPACK pre-post test scores

To answer the third research question, the normality assumptions were checked and met (p>.05). The dependent t-test was run to see whether there was a significant difference between pre-service teachers' TPACK pre-post test scores (Table 4). The dependent t-test results revealed that there was a meaningful improvement from the pre-test (M = 55.1186, SD = 25.01729) to the post-test (M = 90.0847, SD =12.08488) of the pre-service teachers' TPACK ($t_{(58)}$ = -10.526, p = .000).

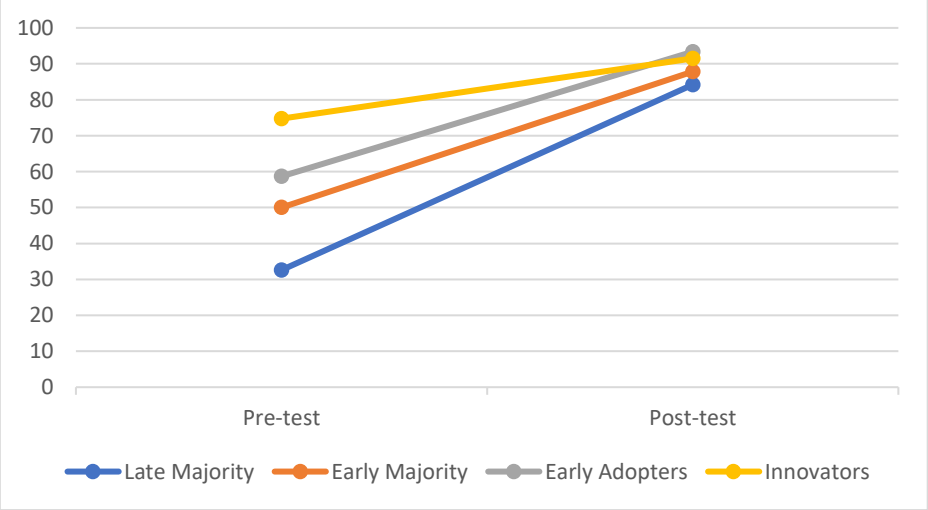

Figure 2: Pre-service teachers' TPACK pre-post test scores change by their innovativeness levels

Figure 2 indicates that all groups of pre-service teachers' TPACK were improved. At the end of the course, their TPACK scores were observed to be close to each other regardless of their adopter levels. TPACK development in detail is examined in Table 5.

Group	N	Pre-test		Post-test	
		M	SD	M	SD
Late Majority	5	32.6000	18.76966	84.2000	15.20526
Early Majority	24	50.0000	19.66900	87.8333	12.61009
Early Adopters	22	58.6818	22.07430	93.3636	11.03046
Innovators	8	74.7500	36.31902	91.5000	10.59650

Table 5: Descriptive statistics of pre-service teachers' TPACK pre-post test scores change by their innovativeness levels

Table 5 displays how pre-service teachers' TPACK pre-post test scores change by their innovativeness levels. TPACK scores of Late Majority group (M_{pre}= 32.6000, SD=18.76966; M_{post}=84.2000, SD=15.20526), Early Majority group (M_{pre}= 50.0000, SD=19.66900; M_{post}=87.8333, SD=12.61009), Early Adopters group (M_{pre}= 58.6818, SD=22.07430; M_{post}=93.3636, SD=11.03046), and Innovators group (M_{pre}= 74.7500, SD=36.31902; M_{post}=91.5000, SD=10.59650) were increased.

	Sum of Squares	df	Mean Square	F	p
Between Groups	547.352	3	182.451	1.267	.295
Within Groups	7923.224	55	144.059		
Total	8470.576	58			

Table 6: Post-test scores of pre-service teachers' TPACK differ by their individual innovativeness levels

The Shapiro–Wilk Normality Test and Levene Test results were satisfied (p>.05) to compare the post-test scores of pre-service teachers' TPACK by their individual innovativeness levels (Table 6). Performing ANOVA, the analysis results showed no significant difference between pre-service TPACK scores by their individual innovativeness level end of the course ($F_{(3\text{-}55)} = 1.267$, $p > .05$).

Innovativeness level	Digital		Non-digital		Both		Total	
	f	%	f	%	f	%	f	%
Late Majority	3	60	1	20	1	20	5	100
Early Majority	14	58.3	4	16.7	6	25	24	100
Early Adopters	15	68.2	3	13.6	4	18.2	22	100
Innovators	6	75	1	12.5	1	12.5	8	100
Total	38	64.4	9	15.3	12	20.3	59	100

Table 7: Preference of pre-service teachers end of the course based on their individual innovativeness levels

As shown in Table 7, in total, pre-service teachers' choices yielded digital educational material development at 64.4% (N=38), followed by both types at 20.3% (N=12) and non-digital at 15.3% (N=9) at the end of the semester. The development of digital educational material was preferred by 60% (N=3) of the late majority group, 58.3% (N=14) of the early majority, 68.2% (N=15) of the early adopters, and 75% (N=6) of the innovators at the end of the semester as a final project when they were free to develop any sort of educational materials. Traditional educational material development was the least preferred format among all groups.

Conclusion, Discussion, and Implications

This quasi-experimental research aimed to investigate how pre-service EFL teachers' individual innovativeness levels affect their TPACK development during the Instructional Technologies and Material Development course. Firstly, it was found that the pre-test TPACK scores of the pre-service teachers showed a significant difference in terms of individual innovativeness levels. TPACK of early adopters and innovators groups were meaningfully higher than those of the late majority. This result is consistent with the related literature (Çoklar & Özbek, 2017; Mazman Akar, 2019). Meanwhile, no significant difference was detected between the pre-test and post-test of the individual innovativeness of the participants. In other words, it was determined that the innovation levels of pre-service teachers were not affected by the course given. Even though innovativeness is predicted by psychological factors like goal orientation and risk-taking behaviors (Aldahdouh et al., 2019; Açıkgül Fırat & Torun, 2022), human innovativeness attribution is a persisting feature since it acts as a personality trait (Hurt et al., 1977). This result reveals that the level of innovation was a stable variable during the training program.

At the end of the course, pre-service teachers' TPACK significantly improved. Related research has also produced similar results, indicating that training boosts the TPACK of pre-service teachers (Lachner et al., 2021; Umutlu, 2022). Considering the adoption groups, each group's TPACK scores were enhanced. The greatest increase was seen in the late majority, while other groups' TPACK made progress less than them when considering the starting point of each group. Innovative teachers have a higher perception of the ease of technology use and its usability (Mazman Akar, 2019), and innovativeness determines the user perceptions of innovation characteristics. So, it can be concluded that TPACK development demonstrated a gradual rise in openness to new ideas, possibly due to the mentioned roles of mediator/moderator factors.

Furthermore, the distinguished finding of the study is that the TPACK of the pre-service teachers did not differ according to their individual innovativeness levels end of the semester. Thus, the individual differences arising from openness to experience (e.g. Çoklar & Özbek, 2017) reached almost the same level of technology integration skills. Mazman Akar's (2019) study claims that innovativeness indirectly affects teachers' technology acceptance, while innovativeness positively impacts technology's usefulness and ease of use. In addition, when examining the educational material development preferences at the end of the term by their innovation level, the majority (84.7%) prefer to use digital or hybrid (both digital and non-digital educational materials together). Despite innovativeness being an important variable, it has been concluded that attending an educational technology course is a critical intervention in eliminating the gaps at the beginning regarding TPACK knowledge and skills of pre-service EFL teachers. Therefore, the results of this study provide evidence that training programs designed without considering the innovation levels of teacher candidates can be beneficial for all adoption groups when the necessary information about new technologies is presented, and observability and trialability opportunities are provided to develop technology integration skills.

Contrary to previous studies' recommendations about the arrangement for instruction by miscellaneous adopters' categories (e.g. Martins, 2018; Mumcu, 2022) or identifying innovative teachers as role models to show the benefits of the technology to their colleagues (e.g. Mazman Akar, 2019), this study's findings may put them in a controversial position. Because innovative teachers may influence or be perceived negatively in their collegial interaction at schools regarding technology integration procedures (Kulaksız & Karaca, 2022), even though it was known their number is small. It is approximated that grouping pre-service teachers by their innovativeness level may broaden the range arising from the

difference in prior TPACK knowledge and technology usage experience. Instead of further consolidating the knowledge gap in their TPACK, instructional design processes should be carried out meticulously on how to use the differences in the most efficient way to reach common goals. Moreover, how class dynamics are in a relationship network in this context is still unrevealed. For instance, do innovators act as natural innovation ambassadors or role models to others based on their last products? Since there were no laggards in the study sample, it is also unknown how the laggards group affects the classroom dynamics or what kind of TPACK improvement they could demonstrate. How do different levels of innovators support each other during peer interactions? Are personal experiences or peer representations more effective in eliminating anxiety, negative attitudes, etc. of late majorities?

Based on the results of the study, it is suggested that practitioners deliver practice-based and context-oriented training programs to reduce the initial innovativeness difference gap and achieve learning outcomes for TPACK. This way, pre-service teachers can concentrate on becoming aware of the usability and learnability of digital tools, comparing the advantages and disadvantages of the technology used in lessons, and implementing them effectively. In future studies, it is considered necessary to investigate how individual innovativeness and initial diverse TPACK leads to the interaction between peers during classroom learning, either individually or collaboratively constructing TPACK.

Using quantitative data, this study was conducted with a relatively small group and no laggard category was in the sample. Therefore, it is recommended to repeat the study with a larger sample group, including individuals from all levels of innovation. In this study, a mechanism to observe the psychological difficulties faced by each innovation group was not employed. In future research, TPACK development can be investigated in detail using qualitative research methods. Although the decision phase was left optional, and the free choice was guaranteed at the end of the training, there is a possibility that the participants may be influenced by the instructor or their peers during the decision-making phase. This course was conducted only for one semester. However, due to everyone's innovation adoption being a different process (Roger, 2003), longer-term interventions can yield different results regarding the educational technologies adoption of the participants. By triangulation data from multiple sources, the variables affecting the decision-making of the participants can be comparatively explored in subsequent repetitive studies.

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